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Regular Research Article

Implementing HSSE Through a Safety Culture Perspective to Enhance Maritime Safety Performance: A Study on Medium-Sized Vessels in Indonesia

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Abstract: This study examines how the implementation of Health, Safety, Security, and Environment (HSSE) practices is associated with the shaping of safety behavior and perceived maritime safety performance on medium-sized vessels in Indonesia. Adopting an interpretivist qualitative approach, the study employs a single-case study design with data collected through semi-structured interviews with 18 crew members across managerial, operational, and support levels, complemented by field observations and archival safety documents. Guided by the Gioia methodology, the analysis identifies three interrelated mechanisms through which HSSE practices are interpreted and enacted at the shipboard level: the internalization of safety values through leadership and safety communication, the reinforcement of safe behavior through collective norms and peer accountability, and the enactment of trust-based reporting and continuous learning. The findings suggest that HSSE does not automatically translate into high safety performance; rather, its effectiveness is understood to be contingent upon the presence of a supportive safety culture and the enactment of everyday safety behaviors by crew members. Supportive safety leadership, two-way communication, and non-punitive reporting systems are consistently described as facilitating safety compliance and safety participation, which are associated with heightened risk awareness, improved coordination across shipboard functions, and fewer unsafe acts during complex operations. Theoretically, this study advances HSSE and safety culture scholarship by explicitly conceptualizing safety culture as a social and interpretive mechanism that mediates the translation of formal HSSE systems into lived safety practices. By moving beyond a procedural view of HSSE, the study extends Safety Culture Theory through a micro-operational perspective, offering analytically transferable insights for similar high-risk maritime contexts.

Keywords: HSSE implementation; safety culture, safety leadership, safety behavior, maritime safety performance

1. Introduction

Maritime safety has become a strategic concern for Indonesia as the rapid growth of seaborne trade and rising geopolitical pressures are accompanied by persistently high accident rates. International reports indicate that incidents involving machinery breakdown, fire, collision, cargo-handling failures, and operational disruptions at sea continue to account for a significant proportion of financial losses and supply-chain interruptions, despite a declining trend in total vessel losses over the past decade [1]. Within this context, HSSE (Health, Safety, Security, and Environment) is no longer viewed merely as a regulatory requirement but as a fundamental prerequisite for business continuity and workforce protection in the maritime sector. In this study, HSSE is understood as a formal managerial system encompassing policies,

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procedures, organizational roles, and control mechanisms designed to manage safety-related risks. Studies on HSSE integration within Indonesian shipping and logistics companies emphasize that a mature HSSE management system enhances long-term performance and competitiveness, yet implementation at the operational level remains challenged by varying standards and cross-functional coordination issues [2]. These gaps highlight the need for more focused inquiry into how HSSE is enacted on board ships and the extent to which such implementation tangibly influences maritime workforce safety performance.

Ships, as critical nodes within the maritime logistics chain, carry inherently high safety risks due to the concentration of complex and interdependent operational activities within limited space ranging from cargo handling operations, deck equipment usage, and internal vehicle or machinery movements to the continuous mobility of crew across dynamic work areas. However, the presence of formal HSSE systems alone does not guarantee safe outcomes unless they are meaningfully interpreted and enacted by crew members through shared norms and everyday practices. The simultaneous interaction between humans, machines, and materials significantly increases the likelihood of incidents when operational coordination, procedural compliance, and risk-control mechanisms are not consistently maintained across all work processes on board [3]. Empirical studies further reveal that a substantial proportion of cargo-ship incidents can be traced to human factors, including operator error, communication breakdowns, and rapidly changing work conditions inherent to the complexity of shipboard environments [4], [5].

Recent investigations into HSSE risks in ship operations show that maritime workers are exposed to various physical, ergonomic, chemical, and systemic hazards, often exacerbated by inconsistent safety governance, thereby reinforcing the need for a more integrated approach to safety management [6], [7]. This indicates that safety outcomes are shaped not only by formal HSSE provisions, but also by the social and cultural processes through which those provisions are embedded in daily work. Complementary studies in Indonesia indicate that growing operational intensity and complexity particularly during cargo transfer between ship and port, from arrival and berthing activities to the hazards emerging from human and equipment-related factors consistently elevate the potential for operational incidents when not supported by comprehensive HSSE and risk-management practices [8], [9], [10]. At the same time, national discourse on HSSE within ship environments tends to emphasize the importance of safety culture, PPE usage, and operational supervision, yet systematic empirical evidence demonstrating the linkage between shipboard HSSE programs and measurable maritime safety performance remains limited. This situation underscores a critical empirical context for examining how HSSE implementation on board contributes to incident prevention and crew protection across Indonesia's maritime sector.

Globally, research on maritime safety and safety culture continues to grow; however, recent bibliometric analyses reveal that the transportation and logistics sectors remain relatively underexplored compared with other high-risk domains such as healthcare or energy [11]. Trends in Maritime Safety Management System research also show that many studies emphasize ISM Code compliance, while the mediating role of safety culture in translating safety management systems into operational practice remains insufficiently examined, particularly in developing countries [12]. This gap underscores the need for studies that explicitly link HSSE design and implementation on board vessels with concrete indicators of maritime safety performance, such as incident frequency, near-miss occurrence, operational disruptions, and procedural compliance among crew and port workers. In other words, both the causal and practical relationships between HSSE practices and maritime safety performance in the Indonesian context remain largely underdeveloped and present meaningful opportunities for further investigation. Although several studies have investigated occupational safety for example, safety risks in dry bulk loading–unloading operations at Tanjung Wangi [13] and safety management risk analysis at Tanjung Perak [14], there remains a significant gap in understanding how HSSE systems are operationalized comprehensively within ship-berthing environments to reduce maritime incident risks, especially in liquid bulk and general cargo terminals.

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A growing body of empirical research demonstrates that safety culture, safety management systems, and the quality of training interventions play a pivotal role in reducing accidents in the maritime sector. Recent studies in the shipping industry show that dimensions of safety culture such as safety management culture and safety value fit positively influence officers' safety behavior and significantly reduce the likelihood of maritime accidents [15]. Complementary evidence from MSMS-related research indicates that strengthening ISM Code–based Safety Management Systems remains essential to addressing audit findings and vessel detentions that persist despite regulatory compliance [12]. In the Indonesian context, studies on safety leadership and HSSE culture formation among cadets and emerging maritime leaders highlight that early internalization of safety values contributes to safer work behavior once they enter the maritime workforce [16]. However, there is still a notable gap in the literature: few studies explicitly integrate the HSSE framework with the operational realities of Indonesian vessels or link these dynamics directly to maritime safety performance indicators within a specific vessel type. This gap underscores the need for more context-sensitive and operationally grounded investigations.

Amid the dominance of studies focusing on offshore operations and seafarers at sea, this research introduces novelty by shifting attention to HSSE implementation aboard vessels as a critical node in the maritime safety chain. Previous HSSE research has largely emphasized corporate-level integration within safety management systems, while the micro-operational context of port-related activities where vessels, cargo-handling equipment, and workers interact intensively remains comparatively underexplored [2]. In contrast, maritime safety studies in Europe highlight that human factors and safety culture play a central role in explaining dockside accidents during berthing and cargo operations, [17], [18]. This study bridges corporate HSSE perspectives with the operational realities of emerging maritime environments, allowing a more context-sensitive understanding of safety challenges aboard Indonesian vessels.

This study extends the HSSE and safety culture literature by clearly distinguishing HSSE as a formal managerial system and safety culture as a mediating social mechanism through which that system is enacted in everyday shipboard operations. By explicitly separating HSSE as "what is designed" from safety culture as "how it is lived and practiced," this study addresses a key conceptual ambiguity in existing maritime safety research. HSSE is conceptualized as a structured framework of policies, procedures, roles, and control instruments, while safety culture refers to the shared meanings, norms, and interactional practices shaping crew behavior. By moving beyond compliance-focused indicators, the study broadens the understanding of maritime safety performance to include behavioral, relational, and learning-oriented dimensions. The theoretical novelty lies in positioning safety culture as the linking mechanism that translates formal HSSE systems into lived safety practices at the micro-operational level. This perspective advances Safety Culture Theory by demonstrating how leadership practices, safety communication, and trust-based reporting condition the effectiveness of HSSE in high-risk maritime settings. Empirically, the study contributes rare qualitative evidence from medium-sized vessels in Southeast Asia. Guided by the perspectives of Safety Culture Theory and the Health, Safety, Security & Environment (HSSE) framework, this study seeks to address three key research questions:

RQ1: How does HSSE implementation shape safety practices and crew behavior on medium-sized vessels in Indonesia?

RQ2: In what ways does safety culture function as a mechanism linking HSSE implementation to crew safety behavior in achieving high levels of maritime safety performance?

RQ3: How do safety culture factors such as safety leadership, safety communication, and non-punitive incident reporting strengthen safety compliance and safety participation, ultimately enhancing maritime safety performance?

This study provides two main contributions. Theoretically, it advances the safety management literature by offering a qualitative explanation of how HSSE, safety culture, and safety performance interact within the under-researched context of medium-sized vessels. It also extends safety culture theory by integrating maritime-specific characteristics such as hierarchical command structures, sea–shore

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rotations, and shift-based work systems. Practically, the study offers strategic recommendations for national shipping companies, including strengthening safety leadership, enhancing crew competence through continuous training, improving non-punitive reporting systems, and aligning HSSE procedures with daily operational routines. Together, these contributions support both theoretical development and the improvement of operational safety within Indonesia's maritime sector.

1.1 Safety Culture Theory

Safety culture was initially developed from studies of high-risk organizations, emphasizing the importance of shared values, beliefs, and assumptions regarding safety as an integral component of organizational culture. According to [19], safety culture represents an organizational construct shaped by the dynamic interaction of values, beliefs, and behaviors that collectively influence how an organization perceives and manages risk. Their work underscores that safety culture is reflected not only in the presence of formal procedures and policies, but also in genuine managerial commitment, everyday work practices, and communication patterns that encourage incident reporting, continuous learning, and proactive care for safety.

A seminal study characterizes safety culture as a combination of shared values and control systems that shape the collective behavioral norms "the way we do things around here" which differentiates organizations that are genuinely safety-oriented from those that merely comply with formal requirements [20] . More recent work on safety culture maturity models reinforces this view, emphasizing that safety culture comprises a set of organizational and individual characteristics and attitudes that place safety as a predominant priority in all operational decision-making [21]. Theoretical reviews integrating multiple safety culture models reveal that safety culture is not a single construct but a constellation of interacting elements, including management commitment, communication, worker participation, and organizational learning systems [22]. Contemporary conceptual analyses also differentiate between safety culture (deeply rooted values and assumptions) and safety climate (collective perceptions at a given point in time), though both are viewed as distinct but related levels of the same overarching phenomenon an organization's orientation toward safety [23].

1.2. Mechanisms of Safety Culture in Shaping Safety Behavior and Safety Performance

Theoretically, Safety Culture Theory posits that safety culture influences organizational safety outcomes through the development of several interconnected subcultures such as reporting culture, just culture, learning culture, and flexible culture which collectively enable an organization to become an informed culture [20]. A strong safety culture is believed to enhance safety motivation, procedural compliance, and proactive participation among workers, ultimately reducing accident rates and operational incidents. This proposition is supported by recent empirical studies showing that key dimensions of safety culture management commitment, employee safety awareness, communication quality, and training significantly affect workers' safety motivation and safety behavior [24]. A global meta-analysis on the use of personal protective equipment further demonstrates that patterns of PPE utilization or neglect are closely tied to the strength of an organization's safety culture and the effectiveness of its training systems, underscoring the importance of cultural interventions in improving safe behavior [25]. Additional studies reveal that safety culture enhancement programs implemented across manufacturing and healthcare sectors foster more proactive safety approaches and reduce incident occurrences by strengthening training, supervision, and reporting mechanisms [26]. Within the maritime context, human critical success factors such as safety commitment, communication, and incident learning are recognized as core elements of safety culture that shape the effectiveness of maritime safety improvement efforts [27].

1.3. Safety Culture in the Maritime and Ship Operational Context

In the maritime sector, safety culture is widely recognized as a pivotal factor that links formal safety policies with the everyday behaviors of ship officers and crew. Recent studies in the shipping industry demonstrate that dimensions such as safety management culture and safety

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value fit exert a direct influence on officers' safety behaviors and, through this mechanism, help reduce the likelihood of maritime accidents [15]. Within ship operations, emerging research highlights that human factors and safety culture represent both a challenge and an opportunity for creating a safe working environment, as crew members are exposed to a combination of physical, ergonomic, and systemic risks that demand robust safety governance [7]. Scoping reviews and evaluative studies on maritime operations further emphasize that workers' perceptions of management commitment and safety practices serve as critical indicators of safety culture quality and can function as leading indicators of overall safety performance [28]. Collectively, these findings reinforce the relevance of Safety Culture Theory as a theoretical foundation for explaining how HSSE implementation on medium-sized vessels shapes safety motivation, safe behavior, and ultimately enhances maritime safety performance.

1.4. HSSE (Health, Safety, Security, Environment)

The HSSE (Health, Safety, Security, and Environment) framework emphasizes that maritime safety can only be achieved when worker health, operational safety, facility security, and environmental protection are managed in an integrated, risk-based system. Studies indicate that incorporating these four HSSE pillars into maritime organizational strategies enhances the effectiveness of risk control, strengthens safety culture, and significantly reduces incident rates [2]. Furthermore, a study by [29] assessing HSSE practices on UK-flagged vessels found that poor coordination between safety and security functions was a major contributor to severe accidents, underscoring the need for HSSE implementation to operate as a unified system rather than separate functional silos.

Research by [30] also demonstrates that vessels adopting integrated HSSE approaches exhibit more consistent operational standards, stronger risk communication, and lower accident frequencies compared to those without such integration [5] further highlight that human factors such as workload, fatigue, and safety competence must be embedded within the HSSE framework, as they represent critical antecedents of maritime incidents. In addition, predictive HSE models developed by [31] show that organizations with mature HSSE systems are better able to detect early risk patterns and respond adaptively to emerging threats, ultimately improving operational safety performance. Taken together, these findings position HSSE as a crucial theoretical lens for explaining how vessels such as operating enhance maritime safety performance through comprehensive and integrated risk management practices.

1.5. Safety Performance

In maritime management scholarship, maritime safety performance is conceptualized as a multidimensional construct that reflects the overall effectiveness of safety systems in preventing accidents, reducing near-miss events, minimizing Port State Control (PSC) deficiencies, and fostering safe behavior at both the crew and organizational levels. Recent literature indicates that maritime safety performance is shaped by a combination of structural factors such as bridge resource management, vessel infrastructure and equipment conditions, crew competence, and fleet quality and regulatory elements, including PSC inspection records and compliance with international conventions. Consequently, maritime safety cannot be reduced to technical vessel attributes alone but must be understood as an interplay between operational, human, and regulatory dimensions [32].

At the micro level, empirical studies involving ship officers and crew demonstrate that behavioral dimensions particularly safety compliance and safety behavior are essential components of overall safety performance and are strongly shaped by the prevailing safety culture and safety climate onboard [15]. Safety behavior reflects proactive actions that extend beyond basic compliance, including participation in safety activities, hazard reporting, providing safety-related feedback, and assisting colleagues during high-risk operations. Recent empirical findings confirm that safety behavior plays a critical mediating role in maritime safety performance, acting as the mechanism through which safety culture translates into tangible safety outcomes in operational settings [15], [33].

Furthermore, [27] highlight that human factors such as risk perception, safety motivation, and work experience significantly influence

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variations in safety behavior across shipboard and port environments. Complementary evidence from [33] shows that a positive safety climate fosters proactive crew engagement in risk management, positioning safety behavior as a key element that strengthens maritime organizational resilience amid operational complexity. At the macro level, analyses of Port State Control (PSC) inspection reports and recent maritime safety literature indicate that deficiencies undermining safety performance frequently originate from technical shortcomings, procedural weaknesses, and human factors, including inadequate training and inconsistent adherence to safety protocols [34]. Strengthening these dimensions is therefore essential for achieving systemic improvements in maritime safety performance.

Accordingly, this study conceptualizes maritime safety performance as an outcome arising from the interaction of structural controls (systems, inspections, and regulatory compliance), the quality of safety management and safety culture, and the safe behaviors enacted by crew members all of which must be examined holistically to understand their combined influence on safety outcomes.

2. Materials and Methods

2.1. Analysis And Coding

The use of a single-case study design is justified on methodological and theoretical grounds. The selected medium-sized vessel represents a revelatory and critical case [35], providing rare access to HSSE implementation within daily operations characterized by high safety risks, intensive cargo handling, and tightly coupled interactions among leadership, crew, and operational systems. Consistent with an interpretivist perspective [36], this study examines safety behavior and HSSE practices within their natural operational setting, where meanings and interactions can be directly observed.

Rather than pursuing statistical generalization, the study aims for analytical transferability. The vessel was selected because its operational characteristics make it a suitable example of a case with unique and revelatory conditions [35]. Transferability is supported through thick description, transparent analytical procedures, and triangulation of interview data with field observations and archival safety records. Accordingly, the single-case design serves as a strategic methodological choice for generating context-rich insights into HSSE implementation in maritime operations.

Data were analyzed using the Gioia methodology [37], which maintains a clear link between empirical evidence and conceptual development. First-order codes were generated inductively from interview transcripts, capturing participants' own words and experiences related to HSSE practices, safety culture, and safety performance. This approach is widely used to identify recurring patterns and underlying meanings within qualitative data [36]. Following [38], the analysis emphasized rich description and deep interpretation, while coding was conducted only after data collection was completed to minimize confirmation bias [39].

First-order concepts were subsequently grouped into second-order themes and aggregate dimensions. This process identified three key mechanisms influencing safety performance: (1) internalization of safety values through leadership, (2) regulation of safety behavior through social norms and peer collaboration, and (3) enhancement of safety performance through collective learning and organizational support. The coding process was guided by engaged scholarship principles [40], with safety leadership, compliance, participation, and safety performance serving as analytical anchors. Coding was conducted independently by three researchers and reviewed by a fourth researcher, with disagreements resolved through consensus [36]. Field observations and archival documents were further used to strengthen triangulation.

The Gioia approach enabled a systematic progression from empirical data to first-order concepts, second-order themes, and aggregate dimensions, resulting in a conceptual model that explains how HSSE implementation shapes safety culture and enhances maritime safety performance. To ensure trustworthiness, researcher reflexivity was maintained throughout the study. Multiple-coder analysis, iterative discussions, and cross-validation with observational and documentary evidence were employed to reduce interpretive bias and enhance analytical transparency, thereby strengthening the credibility of the findings.

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2.2. Informants

A total of 18 informants participated in this case study. The selection process was designed to represent the three structural levels on board: management level, operational level, and supporting level. Informants at the management level were identified through purposive sampling, while supervisors and operators were selected using random sampling based on the crew ID list, ensuring diversity in roles and experiences. Specifically, the study interviewed 4 individuals from the management level, 4 from the operational level, and 9 from the supporting level. These informants came from various strategic and operational functions directly involved in HSSE implementation and day-to-day safety activities on the vessel.

The composition of the 18 crew members reflects the hierarchical structure of shipboard safety management senior officers, operational crew, and support personnel providing a comprehensive perspective on how HSSE is enacted across different roles. Variations in rank, tenure, and operational responsibilities allowed the researchers to capture differences in perceptions and experiences regarding procedural implementation, compliance with international regulations, interdepartmental coordination, and the safety challenges encountered during routine tasks. This diversity enabled a holistic understanding of HSSE practices within the operational context of a medium-sized vessel and how these practices influence maritime safety performance. A summary of the informants' profiles is presented in Table 1.

Table 1. Demographic Profile of Interviewees (N = 18)

Participant	Shipboard Position / Department	Years of Sea Service	Gender	Translation Required (Yes/No)	Number of Interviews
Senior Officer 1	Captain (Master)	15 years	Male	No	1
Senior Officer 2	Chief Officer (Deck)	12 years	Male	No	1
Senior Officer 3	Chief Engineer (Engine)	10 years	Male	No	1
Senior Officer 4	Second Engineer	10 years	Male	No	1
Operational Officer 1	Third Officer (Navigation)	9 years	Male	Yes	1
Operational Officer 2	Second Officer (Watchkeeping)	8 years	Female	Yes	1
Operational Officer 3	Fourth Engineer	8 years	Male	No	1
Operational Officer 4	Electrical Technical Officer (ETO)	6 years	Male	Yes	1
Crew 1	Bosun / Boatswain	6 years	Male	Yes	1
Crew 2	Able Seaman (AB)	5 years	Male	Yes	1
Crew 3	Ordinary Seaman (OS)	4 years	Male	Yes	1
Crew 4	Oiler	4 years	Male	Yes	1
Crew 5	Wiper	3 years	Male	Yes	1
Crew 6	Engine Fitter	4 years	Male	No	1
Crew 7	Pumpman	3 years	Male	No	1
Crew 8	Cook / Galley	3 years	Female	Yes	1
Crew 9	Safety Officer / Deck Cadet	2 years	Male	Yes	1
Total	—	—	—	—	18

2.3. Interviews

Semi-structured interviews were conducted with all informants using a predefined question guide to ensure consistency in data collection while still allowing space for the exploration of emerging issues during the conversation [36]. All interviews were carried out between September and November 2025. The process began with senior management, and insights obtained from these initial interviews were used to refine

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subsequent interview protocols, particularly in sessions where an interpreter was required. Informed consent was obtained from every participant, either in Indonesian or English, before the interview commenced.

The interview guide was developed using open-ended questions to encourage participants to provide in-depth reflections on their experiences with HSSE implementation, safety culture, and maritime safety performance aboard medium-sized vessels. The interviews focused on exploring: (1) how HSSE procedures were embedded in daily work routines and the extent to which shipboard leadership influenced crew compliance; (2) how safety values and norms were formed, shared, and enacted to create a safety culture that supports safe behavior; and (3) how the interaction between HSSE practices and safety culture contributed to safety performance outcomes, including incident prevention, accident reduction, and the strengthening of safety discipline on board. Follow-up questions were used to map patterns of interdepartmental coordination, communication mechanisms during high-risk situations, crew perceptions of non-punitive safety reporting, and the forms of organizational support that most strongly affected operational safety. In addition, the interviews examined how trust was developed between officers and crew members, as trust was viewed as a critical element for safety compliance, incident reporting, and effective safety collaboration. The complete set of interview questions is presented in Table 2.

Table 2. Research Questions and Associated Interview Protocol

No	Interview Question	Management Level (Captain / Officers / Safety Officer)	Operational Level (Bosun / AB / Oiler / Crane / Deck Crew)	Supporting Level (HSSE Field / Technician / HR / Security)	Related RQ
1	How do you describe the safety culture onboard and crew safety awareness?	✓	✓	✓	RQ1
2	What HSSE programs and safety practices are most influential in shaping safe behavior on board?	✓	✓	✓	RQ1
3	What key factors enabled the ship to maintain low accident/incident rates in recent years?	✓	✓	✓	RQ1
4	How do officers communicate safety expectations and reinforce safe behavior daily?	✓	—	—	RQ1
5	How are safety training and drills perceived helpful or just mandatory routines?	✓	✓	✓	RQ1
6	How do crew typically respond when unsafe acts/conditions are identified?	✓	✓	✓	RQ2
7	Can you describe a difficult/emergency situation and how safety leadership influenced responses?	✓	✓	—	RQ2
8	To what extent do trust and teamwork influence crew safety compliance?	✓	✓	✓	RQ2
9	Which leadership behaviors have the most positive impact on safety performance?	✓	✓	—	RQ2
10	What challenges still prevent full HSSE	✓	✓	✓	RQ2

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No	Interview Question	Management Level (Captain / Officers / Safety Officer)	Operational Level (Bosun / AB / Oiler / Crane / Deck Crew)	Supporting Level (HSSE Field / Technician / HR / Security)	Related RQ
	compliance? (workload, fatigue, tools, etc.)				
11	What resources or support from ship/company make HSSE implementation easier?	✓	✓	✓	RQ3
12	How effective are safety drills, coaching, and training in improving skills and reducing incidents?	✓	✓	✓	RQ3
13	Does the ship conduct proper safety learning (debriefing after incidents/near-miss)?	✓	✓	✓	RQ3
14	What improvements are needed to strengthen safety climate onboard?	✓	✓	✓	RQ3
15	What leadership/organizational practices are crucial for long-term maritime safety performance?	✓	✓	✓	RQ3

2.4. Field Observation

Field observations were conducted in late November 2025 to obtain contextual insights into safety practices and operational dynamics aboard a medium-sized vessel during both sailing and berthing activities. Following the perspective of Myers [36], fieldwork enabled the researcher to directly capture how safety attitudes, values, and norms were manifested in the crew's day-to-day operational behavior. During the observation period, attention was focused on navigation processes, deck operations, engine-room tasks, inter-officer communication, the use of personal protective equipment, and adherence to international safety standards such as the ISM Code and SOLAS.

Informal discussions with crew members were carried out as they performed routine duties under varying work conditions, while field notes and visual documentation were collected to strengthen the validity of data interpretation. Prior to the observation, the researcher met with the Chief Officer and the vessel's HSSE Officer to review the onboard safety organization structure and identify the critical operational areas that required close examination. The structured observation plan encompassed all major workspaces, including the bridge, cargo deck, engine room, accommodation areas, and muster stations.

Over the three-day observation period, the researcher monitored actual safety practices, patterns of inter-departmental coordination, and how crew members responded to risks within the complex maritime work environment. This direct observation provided a comprehensive understanding of the vessel's safety culture, including how HSSE values and policies were internalized and upheld across hierarchical levels to support maritime safety performance.

2.5. Translation and Validation Process

All interviews were conducted in Bahasa Indonesia to ensure that seafarers could express their experiences, emotions, and maritime technical terminology naturally within the operational context of the vessel. Transcriptions were prepared in the original language to preserve the integrity of meaning, nuances of safety culture, and the HSSE-specific terminology commonly used in maritime practice. The translation into English was carried out by the lead researcher, who is bilingual and possesses substantial expertise in maritime safety, ensuring accurate interpretation of concepts and technical expressions. To guarantee equivalence of meaning, a portion of the transcripts was independently backtranslated by a bilingual expert with professional experience in maritime operational communication. In addition, key quotations included in the findings section were cross-checked against the original transcripts to

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ensure fidelity to the participants' intended meaning. This procedure ensured that the analysis remained free from linguistic distortion and that the interpretation of the findings accurately represented the seafarers' real-world experiences with HSSE implementation, safety culture, and maritime safety performance.

2.5. Archival Data

The archival data obtained from the ship's HSSE Management served as a vital source of evidence that strengthened the findings of this case study. The documents reviewed included both electronic and printed materials, such as organizational structure charts, HSSE program documentation, ship operational manuals, and a series of safety performance indicators integrated within the HSSE management system. Analysis of these documents provided deeper insights into safety reporting patterns, the effectiveness of incident-prevention mechanisms, and the role of safety leadership in shaping a sustainable risk-control system on board.

In the analytical process, archival documents were not treated as standalone sources but were systematically used to support, contrast, and triangulate the interview findings. Safety policies, SOPs, and operational manuals were examined to compare formal HSSE provisions with crew members' accounts of everyday safety practices, allowing the researchers to identify areas of alignment and divergence between "work as imagined" and "work as done." Safety performance indicators, incident records, and audit reports were analyzed to contextualize participants' narratives regarding reporting practices, leadership involvement, and learning mechanisms, while training and meeting records were used to corroborate claims related to safety communication, participation, and competence development. Through this triangulation, archival data functioned as an interpretive and validation lens that enhanced the credibility, depth, and contextual grounding of the qualitative analysis rather than as a source of causal measurement. A summary of the archival records reviewed is presented in Table 3.

Table 3. Sources of Archival Evidence

No.	Type of Document	Description / Content	Source / Unit	Period Covered	Analytical Purpose
1	Organizational Structure	Shipboard hierarchy, command lines, safety reporting channels, and allocation of HSSE roles	HSSE Manager / Ship Master	2020–2025	To contextualize leadership roles, governance structure, and formal accountability for safety
2	HSSE Program Documentation	HSSE policies, standard operating procedures, permit-to-work systems, and emergency response plans	HSSE Department	2020–2025	To examine the formal HSSE framework and compare "work as imagined" with crew narratives
3	Ship Operational Guidelines	Procedures for navigation, cargo handling, engine operations, and maintenance activities	Marine & Technical Departments	2020–2025	To assess alignment between operational routines and prescribed safety standards
4	Safety Performance KPI Reports	LTIFR, TRIR, training frequency, compliance indicators, and internal HSSE audit results	Safety Performance Unit	2020–2025	To provide contextual trends supporting interview accounts of safety performance and monitoring
5	Incident and Non-Compliance Records	Accident reports, near-miss logs, unsafe acts/conditions, and corrective action tracking	HSSE Officer	2020–2025	To identify recurring risk patterns and triangulate perceptions of reporting practices and learning
6	Safety Training and Competency Records	Training schedules, attendance logs, certification records, drills, and refresher programs	Human Capital & HSSE Division	2020–2025	To corroborate claims related to safety competence, participation, and learning processes
7	Safety Audit and Inspection Reports	Internal/external audits, ISPS inspections, Port State Control (PSC) reports, and vetting outcomes	Compliance Division	2020–2027	To assess compliance dynamics and organizational responses to safety findings
8	HSSE Meeting Minutes	Minutes of HSSE meetings, toolbox talks, safety discussions, and improvement actions	Ship Master / Safety Committee	2020–2025	To examine safety communication processes and collective decision-making related to HSSE

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3. Results

RQ1: How HSSE Implementation Shapes Maritime Safety Performance Through Safety Culture and Crew Behavior on Medium-Sized Vessels?

The Gioia analysis identified three interrelated dimensions explaining how HSSE implementation influences maritime safety performance on medium-sized vessels: (1) internalization of HSSE values through leadership and safety communication, (2) behavioral adaptation through collective responsibility and peer influence, and (3) safety performance enhancement through trust-based coordination and continuous learning.

First, participants emphasized the critical role of leadership in shaping safety culture. Captains and senior officers reinforced safety values through routine briefings, consistent application of procedures, and visible role modeling. As one bosun noted, “If the chief officer follows procedures and wears PPE properly, the crew will automatically follow.” These findings suggest that leadership behavior strengthens safety norms and promotes adherence beyond formal compliance.

Second, safety behavior was strongly influenced by group norms and collective responsibility. Crew members described frequent peer reminders, mutual monitoring, and informal interventions during high-risk operations. A crane operator explained, “We signal each other when someone is in a dangerous position... not to blame, but to protect one another.” Such interactions demonstrate how trust and constructive peer influence encourage safe behavior in daily operations.

Third, participants highlighted enabling conditions including safety training, open communication of incidents and near misses, and non-punitive reporting systems. A safety officer stated that crews are more willing to report hazards when reporting is appreciated rather than punished. These conditions foster trust, shared learning, and sustained engagement with HSSE practices.

Overall, the findings indicate that HSSE implementation influences safety performance through a socio-cultural process rather than a simple causal mechanism. Leadership, communication, peer influence, and learning collectively shape how safety values are interpreted and enacted, ultimately contributing to maritime safety performance on board medium-sized vessels.

RQ2: How does safety culture function as a mechanism that links HSSE implementation to crew safety behavior in producing high levels of maritime safety performance?

The thematic analysis suggests that safety culture serves as the key mechanism through which HSSE implementation influences crew safety behavior and maritime safety performance. Rather than acting as a direct mediator, safety culture operates through shared values, routines, and interaction patterns that shape how HSSE principles are applied in daily operations. Three interconnected mechanisms emerged: (1) internalization of safety values, (2) habitual safety behaviors, and (3) a non-punitive reporting climate.

First, participants described safety as an integral part of their work identity rather than merely a regulatory requirement. Safety considerations routinely influenced operational decisions, reflecting the internalization of HSSE values as collective norms. As one second officer stated, “When safety becomes part of the culture, we automatically ensure everything is safe before starting work.”

Second, shared safety values were reinforced through routine practices such as PPE use, toolbox meetings, risk communication, and cross-department coordination. Participants emphasized that HSSE procedures are effective only when applied consistently across all organizational levels. A bosun noted, “SOPs only work if everyone follows them, from the captain down to the newest crew member.”

Third, a non-punitive reporting environment encouraged openness, near-miss reporting, and continuous learning. Crew members reported greater willingness to identify and communicate risks when reporting was appreciated rather than blamed. As one third engineer explained, “If small incident reports are appreciated, everyone is willing to speak up.”

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Overall, the findings indicate that HSSE implementation contributes to safety performance when translated through a shared safety culture. The collective understanding of safety values, their enactment in routine behaviors, and a climate of trust and learning encourage proactive safety engagement and strengthen maritime safety performance on medium-sized vessels.

RQ3: How do safety culture factors such as safety leadership, safety communication, and non-punitive incident reporting strengthen safety compliance and safety participation, thereby enhancing maritime safety performance?

The thematic analysis shows that safety leadership, safety communication, and non-punitive incident reporting are interrelated elements of safety culture that shape safety compliance and participation on medium-sized vessels. Rather than acting as separate drivers, these elements reinforce one another and influence how HSSE practices are translated into daily safety behavior.

First, safety leadership sets the tone for onboard safety. Crew members reported stronger compliance when master's and senior officers demonstrate safe conduct, supervise fairly, and encourage open dialogue. As one able seaman stated, "When the captain personally reminds us about the importance of safety at work, everyone automatically follows." This indicates that leader role modeling strengthens both procedural compliance and safety participation.

Second, safety communication through toolbox meetings, risk assessments, and operational briefings provides a space for reinforcing safety norms. Open and two-way communication helps clarify procedures, improve situational awareness, and encourage crew members to raise concerns. A first officer noted, "When briefings are open and everyone can speak, we become more alert and remind each other more often."

Third, non-punitive incident reporting supports voluntary safety participation. Crew members were more willing to report hazards and near misses when reports were appreciated rather than blamed. As one third engineer explained, "If reports are appreciated, everyone wants to report; if we get scolded, everyone stays silent." This shows how trust and psychological safety encourage proactive safety communication.

Overall, the findings suggest that safety compliance, such as following procedures and using PPE, and safety participation, such as reporting risks and helping colleagues, are mutually connected. HSSE implementation is perceived as most effective when embedded in a safety culture that combines strong leadership, open communication, and trust-based reporting, rather than relying only on formal rules and enforcement.

Table 4. Dimensions and Responsive Strategies for Strengthening HSSE Implementation and Maritime Safety Performance

Contingency	Key Dimension	Main Barriers (Condensed)	Safety Impact	Interpretive Relationship	Actionable Strategies
HSSE Implementation (Job Demands)	Workload & operational complexity	Long shifts, high task rotation, peak operational pressure	Fatigue, reduced vigilance, higher error risk	Inadequate fatigue management constrains safety compliance	Fatigue management aligned with MLC 2006; work-hour monitoring; task-based risk assessment
Safety Culture (Work–Safety Conflict)	Value–practice misalignment	SOP shortcuts; time pressure	Unsafe acts; reduced compliance	Safety culture mediates HSSE–behavior linkage	Safety value alignment; case-based briefings; incident reflection sessions
Safety Leadership (Job Resources)	Supportive leadership	Authoritarian style; limited recognition	Low motivation; reduced participation	Leadership support facilitates safety participation	Empathic leadership training; mentoring; 360° safety feedback
Safety Communication (Org. Support)	Reporting openness	Blame-oriented climate; fear of reporting	Limited learning; recurring incidents	Non-punitive reporting enables safety learning	Just-culture policies; learning-oriented investigations; toolbox talks
Safety Training & Competence	Capability resources	Irregular training;	Procedural deviations; low	Competence strengthens	Scenario-based training; re-

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Contingency	Key Dimension	Main Barriers (Condensed)	Safety Impact	Interpretive Relationship	Actionable Strategies
		competency gaps	confidence	HSSE–performance relationship	certification; simulation learning
Socio-Technical Context	Welfare & connectivity	Limited connectivity; weak psychosocial support	Lower focus; reduced well-being	Welfare support enhances engagement & discipline	Satellite communication; structured rest; tele-counseling

4. Discussion

The findings support a conceptual model in which HSSE functions as a formal management system providing procedures, controls, and safety structures, while safety culture acts as the social mechanism through which these arrangements are interpreted and enacted in daily shipboard operations. Safety culture is reflected in leadership behavior, safety communication, and a non-punitive reporting climate, all of which influence how crew members perceive and respond to safety expectations. This finding is consistent with previous studies showing that a strong safety culture enhances safety behavior and reduces accident risk in maritime operations [15]. The results further demonstrate that HSSE effectiveness depends not only on procedural compliance but also on its integration into everyday operational practices, reinforcing the view that safety culture is a strategic organizational asset linked to operational performance and competitiveness [28].

Crew safety behavior, expressed through safety compliance and safety participation, represents the primary pathway through which safety culture translates HSSE into safety outcomes. Compliance and participation emerge not directly from formal rules but from shared safety values, leadership signals, and peer interactions. When supported by effective communication and leadership, crew members show stronger adherence to SOPs and greater willingness to engage in hazard reporting, mutual monitoring, and safety initiatives. Maritime safety therefore emerges from the alignment between HSSE systems, safety culture, and daily safety behavior rather than from a simple linear relationship.

A particularly important finding is the role of non-punitive reporting. While HSSE provides the reporting framework, safety culture determines whether reporting is perceived as a learning opportunity or a source of blame. Participants indicated that supportive reporting environments encourage near-miss reporting, improve hazard identification, and strengthen organizational learning. This finding aligns with previous studies emphasizing the importance of just culture in effective near-miss management systems [41].

Figure 1. Conceptual Model of HSSE Implementation, Safety Culture, Crew Safety Behavior, and Maritime Safety Performance

Figure 1 summarizes the proposed conceptual model, positioning HSSE as the structural framework, safety culture as the mediating mechanism, and safety compliance and

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participation as the behavioral pathways leading to improved maritime safety performance.

4.1. Theoretical Implications

This study contributes to maritime safety literature by demonstrating that the relationship between HSSE and safety performance is mediated by safety culture and safety behavior. The findings support previous studies that conceptualize safety culture as a collective value system shaping both safety compliance and participation [20], [43]. Furthermore, the results extend existing knowledge by highlighting the importance of non-punitive reporting, safety communication, and leadership within the context of medium-sized vessels in Indonesia. The study therefore addresses a gap in understanding how HSSE systems are translated into operational safety outcomes through social and behavioral mechanisms.

4.2. Practical Implications

From a practical perspective, shipping companies should view HSSE as a cultural transformation initiative rather than merely a compliance requirement. Efforts should focus on strengthening safety leadership, promoting interactive safety communication, and implementing non-punitive reporting systems that support organizational learning [42]. Companies should also invest in scenario-based training, onboard mentoring, and leadership development programs to enhance safety compliance and participation.

In addition, psychosocial support such as reliable internet access for seafarers can improve well-being, concentration, and safety discipline on board. By integrating these measures into operational practice, shipping companies can reduce accident risk, improve operational efficiency, and support long-term workforce sustainability.

5. Conclusions

This study examined factors influencing the operational performance of livestock transportation vessels in Indonesia using SEM-PLS and qualitative interviews. The findings show that service quality and technology application are the main determinants of operational performance. Technology application emerged as the strongest predictor, reflecting stakeholder expectations about the potential of digital systems to improve livestock transportation services.

The role of the Kleder showed a positive but statistically insignificant effect. Although Kleders are important for livestock welfare and onboard animal care, their influence is more directly related to animal management than to broader operational indicators. Variations in competency may also limit the consistency of their contribution.

The regulation variable was excluded from the model due to multicollinearity, indicating that regulatory requirements are embedded within service delivery rather than functioning as an independent operational factor. Thus, service quality becomes the main channel through which regulatory compliance affects operational outcomes.

Practically, the study supports the modernization of Indonesia's livestock transportation system through gradual vessel digitalization, real-time monitoring, improved communication systems, standardized Kleder training, and stronger regulatory monitoring.

This study has several limitations, including the relatively small sample size, the perception-based measurement of technology application, and the limited focus on organizational and operational factors. Future research should use larger samples, evaluate actual digital technology implementation, compare government and private livestock vessels, develop Kleder competency models, and include variables such as port infrastructure, weather, biosecurity, animal welfare indicators, and logistics network performance.

Author Contributions: RWP conceived and designed the study, developed the conceptual framework, conducted data collection and analysis, and drafted the original manuscript. PS supervised the research, contributed to the theoretical foundation and research design, and critically reviewed the manuscript. RR contributed to the methodological design, data analysis strategy, and validation of the research instruments. HD supported data collection in the maritime operational context, provided practical insights on HSSE implementation and shipboard safety practices, and reviewed the manuscript from an operational perspective. NN assisted with data collection, preliminary data processing, and literature review related to maritime safety performance and medium-sized vessel operations in Indonesia. All authors have read and approved the final manuscript.

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